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DETONATION VELOCITY OF THE HYDRAZINUM NITRATE-HYDRAZINE WATER SYSTEM

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DETONATION VELOCITY OF HYDRAZINUM NITRATE-HYDRAZINE-WATER SYSTEM */316

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1. Preface

Mixed explosives that include hydrazine nitrate (hydrazinium nitrate $N_2H_5NO_3$) being a highly volatile explosive exhibit a detonation velocity of 7000-9000 m/sec. The authors have, from among these explosives, chosen to employ, as a high detonation velocity explosive of the explosive lens, a liquid explosive derived from the tertiary mixture hydrozanine nitrate hydrazine and water. This explosive is thought of as having a most excellent explosive quality and as being the easiest for detonation velocity control. However, in order to increase the plane precision of the post explosive wave (shock wave of the lens), it became necessary to investigate in detail the various post explosion characteristics of the tertiary mixture. In order to improve the precision of the plane, it is necessary to note the changes in the detonation velocity brought about by the mixed ratio of the tertiary mixture, the changes of detonation velocity according to the charge diameter and the effects brought upon the detonation velocity by the chemical temperature. According to the methods for high precision measurement of detonation velocity reported previoisly[1], we compared them with a typical liquid explosive nitroethane.

2. Test methods

The explosive used here was a homogeneous mixture of saturated hydrazine (exactly a 91.24% water solution of saturated hydrazine, below written $Hy \cdot H_2O$) dissolved into hydrazine nitrate (below

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* Numbers in margin indicate pagination of foreign text.

written HN). Concerning the weight of the mixed ratio of HN and $Hy \cdot H_2O$ 65/35, 68/32, 70/30, 75/25, we measured the density ρ^{20} of 20°C and the detonation velocity D. For detonation, a 6 electron detonation cap was used but there were instances when detonation could not be achieved. In order to measure the ρ^{20}, we used a vibrational specific gravimeter (made by Anton Paar Company) recording to within four digits of the decimal point.

In Figure 1 is shown the conceptual drawing for the device used for measuring the detonation velocity. Beforehand, we measured the length of the brass tube shown in the figure exactly to 0.1 mm with Vernier calibers. Above and below this tube we attached two twisted enamel wires (0.1mmϕ). Above this we placed another brass tube the same diameter and below this an acrylic board. The enamel wire above and below were connected to the various pulse circuits. Into this device is poured the liquid explosive which is detonated from above. When the post explosive plane wave reaches the two enamel wires, they short-circuit creating the pulse. With this pulse the time counter is started. In the same manner the pulse that comes, when the bottom wire short circuits, stops the pulse counter. The length of the brass tube is approximately 150 mm. The time elapsed is in the tens of μsec and since the valid figures able to be measured are up to 4 digits and the detonation velocity is only 3 digits, we can achieve a precision rate of up to 4 digits. What's more, at temperatures a little away from room temperature, we wrapped the outside of the above device with a vinyl chloride tube with an inside diameter of 75 mm. We filled the space between the brass tube and the vinyl chloride tube with water and at the correct temperature took measurements.

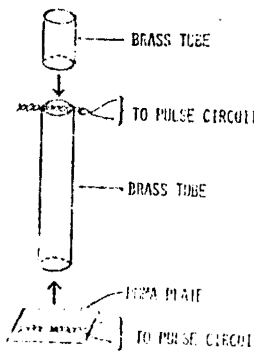

Figure 1. Device for measuring the detonation velocity.

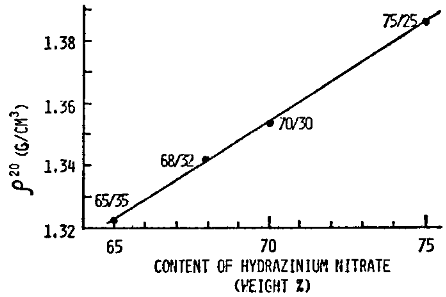

Figure 2. Dependence of ρ^{20} upon mixing ratio.

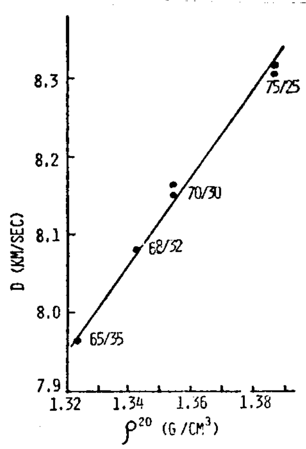

Figure 3. Relation between ρ^{20} and detonation velocity. Tube diameter = 10 mm. Least square method gives $D(\text{km/sec})=5.47\rho^{20}(\text{g/cm}^3)+0.47$

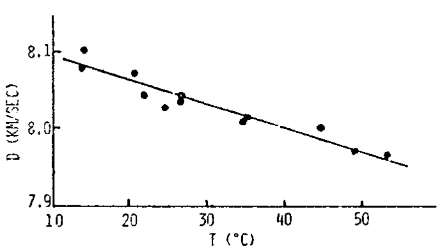

Figure 4. Temperature dependence of the detonation velocity. Tube diameter = 20 mm, mixing ratio = 68/32. Least square method gives $D(\text{km/sec})=-0.00327(°\text{C})+8.13)$

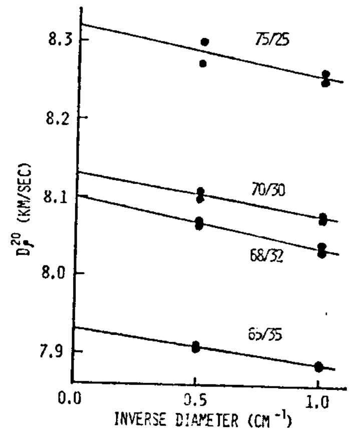

Figure 5. Charge diameter effect on detonation velocity at 20°C

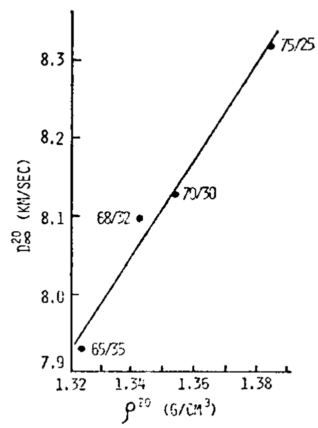

Figure 6. Ideal detonation velocity at 20°C vs ρ^{20}

TABLE 1. A comparison of $HN/Hy \cdot H_2O$ and nitromethane

	dD/dT (msec (1/°C)	charged effect diameter (msec) (1/cm^{-1})
$HN/Hy \cdot H_2O$	-3.2	50
nitromethane	-3.9[2]	40[1]

3. Observations and results of the tests

3.1 The change in detonation velocity according to density

As is shown in Figure 2, we learn that the density of the mixture and the concentration of HN increase together in a linear manner. Figure 3 shows the relationship between the various mixtures' densities and the detonation velocity. This detonation velocity was measured using a brass tube with a diameter of 10 mm. In this figure we get the relationship between D and ρ^{20} through the least square method $D(km/sec) = 5.47\rho^{20}(g/cm^3) + 0.74$.

3.2 The change in temperature of the detonation velocity

Using a brass tube with a diameter of 20 mm concerning the $HN/Hy \cdot H_2O$, we measured the temperature dependence of the detonation velocity. The results are in Figure 4. The dispersion of the basic fixed point was a little large but it was clear that there was a growth in the detonation velocity brought on by the rise in chemical temperature. The least square method yields /317

$$D(km/sec) = -0.00327(°C) + 8.13$$

3.3 Charge diameter effect .

Using the above results, we can do a conversion on the detonation velocity at various temperatures to the D^{20} detonation velocity at 20°C. Also with mixtures of the same makeup through the plot that we construct, even when a small difference is formed in the ρ^{20} as in previously shown relationship to D-ρ the detonation velocity as opposed to the true ρ^{20} can be corrected. As in the above, Figure 5 expresses the charge diameter effect because it plots the detonation velocity D^{20} in opposition to the reciprocal of the diameter of the brass tube. If we take the ideal detonation velocity D^{20} at 20°C we get in relation to 65/35, 68/32, 70/30, 75/25 7930, 8100, 8128, 8318m/sec. This relation plotted against ρ^{20} is seen in Figure 6. Also the charge effect diameter is at a degree of 50(m/sec) (1/cm^{-1}).

Table 1 shows the results gained from these tests compared with the typical liquid explosive nitromethane. As can be seen in the figure, when we compare with nitromethane the temperature change of the detonation velocity is a little small and the charge effect diameter is on the other hand a little large, but there is not a big difference between them. Considering that with this explosive we have two points: one, detonation velocity is large, and two, the level of safety is high. We can say that this is an excellent explosive. We achieved a degree of precision for the time plan of ±0.02 μsec by employing a liquid explosive lens high denotation velocity explosive and also as a low detonation velocity explosive nitromethane having an explosive lens diameter of 65 mm.

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16. Abstract

Detonation velocity of the ternary mixture, hydrazinium nitrate-hydrazine-water, was measured precisely under various conditions. The temperature coefficient, charge diameter effect, and the dependence on mixing ratio were determined. These results were compared with those of a typical liquid explosive, nitromethane.

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